Construction on Reclaimed Land Near the Bay
• **Project description and design requirements**

• **Ground improvement solution**

• **Construction challenges**

• **Better practice of ground improvement**
Proposed Improvement

- 8-Story residential building
- At grade with no basement
- Mat foundation
- Construction is limited to the building footprint.
Surface Conditions

- Relatively flat with 2-ft grade change
- Less than 300-ft from shoreline
- Bay is about 50 deep

Planned Construction

\[
\text{PGA} = 0.65g \text{ and } M_w = 7.5
\]
**Subsurface Condition**

**Depth: 0- to 30-ft**
- **Fill – Sand and Clay**
- **Bay Mud, CH**
  - N = 0
  - Peat
- **Sand and Clay**
  - N = 2-10
  - PI < 7
  - 10-ft

**Depth: 30- to 60-ft**
- **Dense to Very Dense Sand**
  - N = 38-70
  - 15-ft
- **Very Stiff to Hard Clay, OC**
  - To 100-ft
**Identified Hazards**

- Excessive static settlements
- Liquefaction of the sandy layer
- Lateral spreading toward the shoreline

Depth: 0- to 30-ft

![Diagram showing soil layers and identified hazards](image_url)
• Liquefaction triggering between 5- to 10-ft and 20- to 30-ft.
  • Liquefaction settlement < 4-in.

• Liquefaction damage potential:
  • Severe with manifestation expected

• Lateral spreading:
  • Yoshimine et al. (2006): 5.2-ft
  • Zhang et al. (2004): 7.2-ft
Ground Improvement Solution

- Deep-Soil-Mixing (DSM) can be an efficient solution for the proposed project.

- DSM grids will enclose the loose soils and mitigate liquefaction through shear stress redistribution.
Liquefaction Mitigation

Area Replacement Ratio = 40%

Area Replacement Ratio = 50%
Lateral Spreading

- Buttress should extend through the liquefiable materials, and toe into the underlying competent layers.
- Numerical modeling should be carried out to design the depth and extent of the buttress.
- Stability of buttress should be checked both globally and internally.
Lateral Spreading

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Anticipated Direction of Movement

Buttress

DSM panels

100-ft

200-ft

Building Plan
Deep-Soil-Mixing

Triple Auger Mixer

Cutter Head Mixer
Construction Challenges

- Presence of peat poses a challenge to achieve the required soil-cement strength.

- Efficiently incorporating the soil-cement spoils into the final grading.
Better Practice of Ground Improvements

- Ground improvement designs are extremely dependent on our understanding of soil profile.
  - (1) Fine contents, (2) plasticity of soil, and (3) shear wave velocity measurements are crucial information for efficient design of ground improvements.

- Schedule allowance for test programs before production can help contractors to better ensure the quality of their work.

- Open discussions about future costs against today’s construction costs can often result in great savings.
Summary

- DSM grids can be used as an efficient ground improvement solution for waterfront projects with focused footprint construction.

- DSM grids can be designed to meet the static bearing capacity and settlements, as well as, seismic liquefaction, surface manifestation and lateral spreading requirements.

- More information about the soil profile and properties can extensively help optimize the design of ground improvements.

- Open discussions about project priorities and better schedule planning can effectively help practice of ground improvements.